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Comparative study of milk compositions of cattle, sheep and goats in Nigeria

Aduli Enoch Othniel MALAU-ADULI[1] and Yakubu Rade ANLADE[2]

[1]*National Animal Production Research Institute and* [2]*Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria*

ABSTRACT

Variations in the milk composition of Nigerian cattle, sheep and goats (Bunaji, Yankasa and Red Sokoto breeds, respectively), as well as residual phenotypic correlations between the milk constituents, were investigated. Results indicated that sheep and goats differed significantly ($P < 0.05$) from cattle in all constituents except protein percentage, which averaged 5.43%, 5.43% and 5.49%, respectively. Caprine milk contained the highest percentages of fat (5.80%), total solids (15.37%) and ash (0.77%), and bovine milk contained the least percentages of fat (0.68%) and lactose (1.84%). Overall, the milk compositions of sheep and goats were very similar as they were not statistically different from each other ($P > 0.05$). Residual phenotypic correlations between the milk constituents revealed highly significant ($P < 0.01$) and positive relationships between total solids and solids-not-fat (0.97 and 0.98 in cattle and sheep, respectively). All other correlations were positive in cattle (ranging from 0.12 to 0.77), except between protein and total solids (–0.44) and protein and solids-not-fat (–0.64). Multiple linear regression equations were fitted to predict the percentages of protein and fat. It was demonstrated that the protein percentage could be predicted from total solids and solids-not-fat with the highest accuracy of 94%, 86% and 82% in cattle, sheep and goats, respectively. On the other hand, the accuracy of prediction of fat percentage was very low in all the species ($R^2 = 0.01$, 0.03 and 0.37 in cattle, sheep and goats, respectively).

KEYWORDS: Bunaji cattle, milk composition, Red Sokoto goats, Yankasa sheep.

INTRODUCTION

The majority of milk consumed throughout the world is bovine in origin, although in some countries sheep and goats are the common sources. In Nigeria, the most common breeds of cattle, sheep and goats are Bunaji (White Fulani), Yankasa and Red Sokoto, respectively. The Bunaji, which is the most widely distributed cattle breed in Nigeria, is a typical *Bos indicus* with long legs, well-pronounced hump and dewlap, and with a predominantly white coat color. It has an average mature weight of 270–290 kg. A detailed description of the breed, as well as its lactation characteristics and persistency, has been documented (Abubakar & Buvanendran 1980; Ibeawuchi 1984). The Red Sokoto goat is found throughout the subhumid and semi-arid zones of Nigeria. It is a medium-sized breed with a reddish-brown coat and a mature average liveweight of 30 kg, kept for its milk, meat and skin. Detailed descriptions of its herd size (Gefu & Adu 1982), production (Mathewman 1980; Otchere *et al*. 1987), lactation (Ehoche & Buvanendran 1983) and reproductive performance (Adu *et al*. 1979) have been documented. The Yankasa breed of sheep is concentrated mainly in the semi-arid and subhumid zones of Nigeria but it has also been found thriving even in the humid zone. It has a medium body size with a

Correspondence: Aduli Enoch Othniel Malau-Aduli, Laboratory of Animal Breeding and Reproduction, National Agricultural Research Center for Western Region, 60 Yoshinaga, Kawai, Oda, Shimane 694–0013, Japan. (Email: aduli40@yahoo.co.uk; aduli@affrc.go.jp)
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predominantly white coat and black patches around the eyes, muzzle and hooves. Its mature liveweight is approximately 40 kg; detailed descriptions of the breed, its growth and reproductive performances have been reported by Adu and Ngere (1979), Igono *et al*. (1982), Osinowo *et al*. (1982) and Taiwo *et al*. (1982). The present study was conducted to determine variations in the milk composition of these Nigerian cattle, sheep and goats and to compute the phenotypic correlations between the milk constituents.

MATERIALS AND METHODS

We analyzed milk from Bunaji cattle, Yankasa sheep and Red Sokoto goats ($n = 35$ each) that were in their first lactation at the Dairy and Small Ruminant Research Programmes of the National Animal Production Research Institute (NAPRI) Shika, Zaria. The milk samples were collected from animals grazing on natural pasture during the same season, within the same year and stage of lactation. The newborn calves, lambs and kids were allowed to suckle their dams for approximately 1 week to ensure they got all the colostrum and thereafter, the milk samples were collected. Ehoche and Buvanendran (1983) and Malau-Aduli *et al*. (1996a,b) have described the animal management practices in NAPRI, and in the laboratory, standard procedures adopted by the Association of Official Analytical Chemists (1993) were followed in the determination of the percentages of total solids (TS), solids-not-fat (SNF), fat (Gerber's method) and protein (Kjeldahl's method). The lactose percentage was calculated as TS – (protein + fat + ash). One-way analysis of variance was utilized in which species was fitted as a fixed effect in the model using the general linear model procedures (PROC GLM) of SAS (1986) to compute least squares means. Correlation coefficients between milk components were calculated using PROC CORR (SAS 1986) and Bonferroni probabilities for tests of significance were computed. PROC REG (SAS 1986) was used in running simple linear regressions to predict protein and fat percentages.

RESULTS AND DISCUSSION

Caprine milk contained the highest fat (5.80%), TS (15.37%) and ash (0.77%), whereas ovine milk had the highest lactose (3.73%) and bovine milk had the least percentages (Table 1). Overall, the composition of ovine and caprine milk was very similar as they were not statistically different from each other ($P > 0.05$). The fat content of the milk samples in the present study compare favorably with the average percentage of 5.6% for the Zebu reported by O'Connor (1995), but the protein percentage was higher than the value reported for *Bos taurus* (3.5%) and *Bos indicus* (3.4%) by Webb *et al*. (1996). However, the protein percentages of 5.43, 5.49 and 5.43 for cattle, goat and sheep, respectively, agree with the values of 5.4%, 5.6% and 5.9% in the Finn, Lincoln and Rambouillet breeds of sheep, respectively (Sakul & Boylan 1992). The observation that the milk compositions of sheep and goats were not statistically different from each other agrees with the findings of Boujenane and Lairini (1992) and Peters *et al*. (1992) who demonstrated that milk composition was not significantly influenced by the breed of sheep, goats or their crosses.

Residual phenotypic correlations between the milk constituents were all positive, except those between protein and TS (–0.44) and protein and SNF (–0.64) in cattle (Table 2). This implies that as the percentage of protein increases in bovine milk, there is a corresponding decrease in TS and SNF, but this relationship was not statistically significant (Table 2). Our finding supports an earlier observation by Mba *et al*. (1975) in which the correlation between protein and SNF was not statistically significant. On the other hand, highly significant ($P < 0.01$) and positive correlations were observed between TS and SNF (0.97 and o.98 in cattle and sheep, respectively), which indicates a very strong relationship between increasing SNF and corresponding increases in TS.

Multiple linear regressions of protein and fat percentages on TS and SNF were carried out and the

Table 1 Variations in the composition of bovine, ovine and caprine milk (% ± s.e.)

Species	Breed	Protein	Fat	Total solids	Solids-not-fat	Ash	Lactose†
Cattle	Bunaji	5.43 ± 0.09^{a}	4.82 ± 0.11^{a}	12.77 ± 0.58^{a}	7.95 ± 0.58^{a}	0.68 ± 0.02^{a}	1.84 ± 0.01^{a}
Goat	Red Sokoto	5.49 ± 0.14^{a}	5.80 ± 0.14^{b}	15.37 ± 8.44^{b}	9.57 ± 0.42^{b}	0.77 ± 0.03^{b}	3.31 ± 0.12^{b}
Sheep	Yankasa	5.43 ± 0.17^{a}	5.30 ± 0.18^{b}	15.19 ± 0.69^{b}	9.89 ± 0.64^{b}	0.73 ± 0.04^{b}	3.73 ± 0.14^{b}

Column means with different superscripts differ significantly ($P < 0.05$).
†Lactose percentage was calculated as total solids – (protein + fat + ash).

Table 2 Residual phenotypic correlation coefficients between milk constituents in cattle, sheep and goats

Variables	Cattle (Bunaji)	Sheep (Yankasa)	Goats (Red Sokoto)
Protein and fat	0	0.17	0.25
Total solids and protein	−0.44	0.62	0.77
Solids-not-fat and protein	−0.64	0.73	0.77
Fat and total solids	0	0.14	0.51
Solids-not-fat and fat	0	0.12	0.20
Total solids and solids-not-fat	0.97**	0.98**	0.77

**$P < 0.01$.

Table 3 Multiple linear regressions of protein and fat on total solids and solids-not-fat in cattle, sheep and goats

Species	Dependent variable	Intercept (Y)	b_1	b_2	R^2
Cattle	Protein	3.74	0.96	−1.33	0.94
	Fat	5.00	0	0	0.01
Sheep	Protein	5.00	−0.83	1.33	0.86
	Fat	4.50	0.17	−0.17	0.03
Goat	Protein	0.92	0.46	−0.30	0.82
	Fat	2.94	0.31	−0.20	0.37

results are shown in Table 3. It was evident that protein percentage could be predicted from TS and SNF with the highest accuracy of 94%, 86% and 82% in cattle, sheep and goats, respectively, whereas fat percentage could not be accurately predicted. The implication is that we cannot have confidence in the predicted values of fat percentage because the R^2 values were 0, 0.03 and 0.37 in cattle, sheep and goats (Table 3). This in turn infers that simple linear regression equations would be inadequate for predicting fat from TS and SNF. Perhaps other forms of complex regression procedures (e.g. stepwise regression) might be able to improve the accuracy of prediction.

Conclusion

Species variation exists in the milk compositions of cattle, sheep and goats. Caprine milk appears to be more ideal for farmers interested in butter production because it contains the highest fat percentage. The fact that goat, sheep and cow milk contained the same or similar percentages of protein implies that any of them can adequately serve as a nutritional source of protein for human consumption. Total solids and solids-not-fat are highly positively correlated in cattle and sheep, whereas protein and total solids and protein and solids-not-fat are negatively correlated. Therefore, the incorporation of these traits into a selection index should take into consideration these relationships for genetic progress.

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